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|  |  | **Department of Computer Systems Software** |
| **Databases**  **Work program of the discipline (Syllabus)** | | |

# Details of the academic discipline

|  |  |
| --- | --- |
| Level of higher education | First (undergraduate) |
| Branch of knowledge | *12 Information Technology* |
| Specialty | *121 Software engineering* |
| Educational program | *Computer Systems Software* |
| Discipline status | *Normative* |
| Form of education | *daytime* |
| Year of training, semester | *2nd course, fall semester* |
| Scope of the discipline | *4credits (120 hours)* |
| Semester control/ control measures | *Course work, credit* |
| Lessons schedule | [*http://rozklad.kpi.ua*](http://rozklad.kpi.ua/) |
| Language of teaching | *Ukrainian* |
| Information about the course leader / teachers | **Lecturer and Practices***: Ph.D., Assoc.Prof. Andrey Petrashenko,*[*petrashenko@gmail.com*](mailto:petrashenko@gmail.com) |
| Placement of the course | *Google Classroom* |

# Program of educational discipline

# Description of the educational discipline, its purpose, subject of study and learning outcomes

*The educational discipline "Databases and management tools" is aimed at studying the theoretical and methodological foundations of building database management systems (DBMS), mastering the tools for creating and using applied applications and software libraries for the automation of information processes in a wide range of subject areas.*

***The purpose of the credit module****there is the formation of students' ability to create various information models of subject areas, to effectively use tools for the development of applied software tools for automating information processes of the subject area.*

***The subject of the academic discipline****– instrumental and applied software tools for creating modern database applications, SQL declarative language and its dialects, as well as hybrid declarative-imperative data access languages.*

*Studying the discipline "Databases and management tools" contributes to the formation of the following competencies in students.*

**Competencies, the formation of which is facilitated by this discipline:**

*ZK 1 Ability to abstract thinking, analysis and synthesis*

*ZK 2 Ability to learn and master modern knowledge*

*ZK 3 Ability to apply knowledge in practical situations*

*ZK 7 Ability to identify, pose and solve problems*

*ZK 8 Ability to work in a team*

*FC 2 Ability to use modern methods and programming languages ​​for*

*development of algorithmic and software*

*FC 11 The ability to present the obtained work results in the form of presentations,*

*scientific and technical reports*

*FC 12 Ability to identify, classify and describe the operation of software and technical means, computer and cyber-physical systems, networks and their*

*component by using analytical methods and modeling methods.*

*FC 15 The ability to argue the choice of methods for solving specialized problems,*

*critically evaluate the obtained results, justify and defend them*

*decide*

*FC 16 Ability to algorithmic and logical thinking*

*The formation of these competencies ensures the achievement of the following program goals*

***learning outcomes****:*

*PRN 3 To know the latest technologies in the field of computer engineering.*

*PRN 6 To be able to apply knowledge for identification, formulation and solution*

*technical problems of the specialty, using methods that are the most*

*suitable for achieving the set goals.*

*PRN 7 To be able to solve problems of analysis and synthesis of means characteristic of*

*specialty*

*PRN 8 To be able to think systematically and apply creative abilities to formation*

*new ideas.*

*PRN 10 To be able to develop software for embedded and distributed*

*applications, mobile and hybrid systems, calculate, operate typical*

*for the equipment specialty.*

*PRN 11 To be able to search for information in various sources to solve problems*

*computer engineering.*

*PRN 12 To be able to work effectively both individually and as part of a team.*

*PRN 14 To be able to combine theory and practice, as well as to make decisions and produce*

*activity strategy for solving the tasks of the specialty taking into account*

*universal human values, public, state and industrial interests.*

*PRN 16 To be able to evaluate the obtained results and defend the accepted ones with arguments*

*decision.*

*PRN 18 Use information technologies and for effective communication on*

*professional and social levels.*

*PRN 19 Ability to adapt to new situations, justify, accept and*

*implement within the competence of the decision.*

*PRN 20 To be aware of the need for lifelong learning with a purpose*

*deepening of the acquired and acquisition of new professional knowledge, improvement*

*creative thinking.*

*PRN 21 To perform work qualitatively and achieve the set goal in compliance with the requirements*

*professional ethics.*

*PRN 25 To develop software for computer systems and networks using*

*modern programming technologies*

# Pre-requisites and post-requisites of the discipline (place in the structural and logical scheme of training according to the relevant educational program)

*To successfully master the discipline "Databases and control tools", it is necessary and sufficient to have algorithmic programming skills and relevant languages ​​and tools, as well as to have a basic level of English at least B1.*

*Successful mastering of knowledge in this discipline ensures further study of such courses as "Programming technologies" and "Web application development technology".*

# Content of the academic discipline

*CHAPTER 1. Basic logical models of databases*

*Topic 1.1. Hierarchical and network model of databases.*

*Topic 1.2. Introduction to the relational model of databases.*

*SECTION 2. Elements of relational algebra*

*Topic 2.1. Algebra and Codd calculus, their basic and additional operations.*

*Topic 2.2. Development of the theoretical apparatus of relational algebra and relational calculus.*

*SECTION 3. Normalization of relational databases*

*Topic 3.1. Logical connections between relational tables. Types of logical connections.*

*Topic 3.2. Normalization of the relational database. Normal forms.*

*CHAPTER 4. Relational database management systems*

*Topic 4.1.Data presentation models in the database. Generalized structure of DBMS.*

*Topic 4.2.Modern relational databases PostgreSQL, MySQL.*

*Topic 4.3.Elements of the SQL language.*

*SECTION 5. Non-relational databases*

*Topic 5.1.Classification of non-relational databases, features of their application.*

*Topic 5.2. MongoDB as a scalable document database management system.*

# Educational materials and resources

*Basic literature*

* 1. Vasilik, Sylvia Moestl. SQL Practice Problems: 57 Beginning, Intermediate, and Advanced Challenges for You to Solve Using a Learn-by-Doing Approach. 2017.
  2. Beaulieu, Alan. Learning SQL. 2nd ed., O’Reilly Media, 2009.
  3. Regina, and Leo Hsu. PostgreSQL - Up and Running 3e. O’Reilly Media, 2017.
  4. Dombrovskaya, Henrietta, et al. PostgreSQL Query Optimization: The Ultimate Guide to Building Efficient Queries. 1st ed., APress, 2021.

*Supporting literature*

1. Kumar, Vallarapu Naga Avinash. PostgreSQL 13 Cookbook: Over 120 Recipes to Build High-Performance and Fault-Tolerant PostgreSQL Database Solutions. Packt Publishing, 2021.
2. Debarros, Anthony. Practical Sql, 2nd Edition: A Beginner’s Guide to Storytelling with Data. No Starch Press, 2022.
3. Bagui, Sikha Saha, and Richard Walsh Earp. Database Design Using Entity-Relationship Diagrams. 3rd ed., Taylor & Francis, 2022.

# Educational content

# Methods of mastering an educational discipline (educational component)

*The educational content of the discipline consists of lectures and laboratory classes. Lectures on the discipline are conducted using modern multimedia presentation technologies.*

*5.1. Lecture classes:*

|  |  |
| --- | --- |
| *No. z/p* | *The name of the topic of the lecture and a list of main questions* |
| *1* | ***Introduction. Course subject.***  *The history of the development of databases as a field of informatics and computer technology. The place of databases in the system of modern information technologies. Basic definitions.* |
| *2* | ***Basic logical models of databases.***  *Introduction to the relational model of databases. Basic concepts and definitions of the relational approach to the organization of databases. Properties and fields of application of relational databases. Post-relational, XML and NoSQL databases. Changing the methods of logical presentation of data. The problem of optimal selection of a logical database model. Unstructured and hybrid (combined) databases.* |
| *3* | ***Post-relational, XML and NoSQL databases.***  *Changing the methods of logical presentation of data. The problem of optimal selection of a logical database model. Unstructured and hybrid (combined) databases.* |
| *4* | ***Indexing in databases.***  *Hashing functions. Approaches to conflict resolution. Internal addressing. External addressing. Indices based on B-trees, bit indices.* |
| *5* | ***Elements of relational algebra and relational calculus.***  *Algebra and Codd calculus, their basic and additional operations. Precision operation. Merge operation. Difference operation. Cartesian product. Selection operation. Crossing operation.* |
| *6* | ***Connection operation.***  *Theta and equiconnections. A natural connection. Composition. External connection. Division operation. Development of the theoretical apparatus of relational algebra and relational calculus.* |
| *7* | ***Normalization of relational databases***  *Logical connections between relational tables. Types of logical connections. Keys. Classification of keys. Data integrity category in the database. The problem of ensuring integrity. Anomalies in non-normalized databases.* |
| *8* | ***Normal forms***  *Normalization of the relational database. The first normal form. Functional dependencies. The second normal form. Boyce-Codd normal form.* |
| *9* | ***Relational database management systems.***  *Data presentation models in the database. Generalized structure of DBMS. Requirements for relational DBMS. Distributed DBMS. Modern relational DBMS Oracle, Informix, MS SQL Server.* |
| *10* | ***Functions of DBMS linguistic tools.***  *Classification of DBMS language tools. Subtitles of DBMS languages. Request languages. Unification and standardization of DBMS linguistic tools. SQL query language.* |
| *11* | ***Elements of the SQL language. Data sampling***  *The structure of the SELECT query is its components. Filtering, grouping and complex merging of data from different tables.* |
| *12* | ***Elements of the SQL language. Modification of data***  *Inserting data into tables using the INSERT statement. Removing a group of data using the DELETE statement. Data modification using the UPDATE operator. Operations of crossing, joining and obtaining the difference between the sets of records obtained as a result of SELECT.* |
| *13* | ***Application of nested queries***  *SQL aggregate functions in nested queries. Mechanism of parsing and execution of the SELECT statement. Examples of query optimization of connected tables. Advantages and disadvantages of nested SELECT queries.* |
| *14* | ***Transactions in databases***  *Rules for executing and canceling transactions. Definition of a two-step transaction. The set of operations for which transactions are possible. The transaction implementation mechanism in the MySQL DBMS. Administration of MySQL database objects. MySQL database backup and recovery.* |
| *15* | ***Program interface to DBMS***  *Examples of library tools that provide a software interface to the DBMS. Design patterns used when working with DBMS: singleton, class factory, team. Systems of object-relational display on the example of SQL Alchemy.* |
| *16* | ***Centralized and distributed databases.***  *Technological approaches to the organization of databases. Client-server technology. Distributed databases. A fundamental principle of distributed databases. Fragmentation in distributed databases. Replication in distributed databases. Optimization of data distribution between local databases. Distributed query processing. Distributed transaction management. Maintaining integrity in distributed databases.* |
| *17* | ***Non-relational databases***  *Classification of non-relational databases, features of their application.* |
| *18* | ***MongoDB***  *MongoDB as a scalable document database management system.* |

*5.2. Laboratory works:*

|  |  |  |
| --- | --- | --- |
| *No. z/p* | *The name of the laboratory work* | *Number of aud. hours* |
| *1* | *Database design and familiarization with basic PostgreSQL DBMS operations* | *6* |
| *2* | *Creation of a database application focused on interaction with the PostgreSQL DBMS* | *6* |
| *3* | *Tools for optimizing the work of the PostgreSQL DBMS* | *6* |

*In the conditions of distance learning of the 2021-2022 academic year, all types of classes, including control measures, are carried out using the Zoom service.*

# Independent work of student

*Students' independent work consists of the following:*

* *preparation for lectures by studying the previous lecture material as well as literary sources on which the material of the previous lectures is based (a list of sources and a list of sections is provided together with the lecture material);*
* *preparation for laboratory work by getting familiar with the task and methodical instructions for performing laboratory work, including the study of theoretical material necessary for answering control questions for laboratory work;*
* *performance of laboratory tasks and preparation of a report highlighting the results of laboratory work (code listing, analysis of results, etc.).*

*Control of knowledge in laboratory classes is carried out by checking the report on laboratory work and surveys, as well as by performing modular control works.*

*The deadline for performing laboratory work is determined individually for each laboratory work and is specified in the methodical instructions.*

*Table 1. Questions submitted for independent study*

|  |  |  |
| --- | --- | --- |
| *No. z/p* | *The name of the topic submitted for independent processing* | *Number of hours of SRS* |
| *1* | ***Oracle Basics***  *Purpose and architecture of the industrial DBMS Oracle.* | *4* |
| *2* | ***Information and search systems***  *Peculiarities of design and programming of information and search systems. Types of information search.* | *6* |

# Policy and control

# Policy of academic discipline (educational component)

*The system of requirements for the student:*

* *the student is obliged to attend lectures and laboratory classes and actively work on learning the material taught in them;*
* *the teacher uses his own presentation material at the lecture; practices the practical part on a virtual machine;*
* *laboratory work is defended in a laboratory class, having previously issued a report and sent it to the teacher;*
* *a modular test is written during a lecture using all available materials;*
* *penalty points are awarded for: untimely submission of laboratory work. The deadline for the protection of laboratory work without penalty points is determined for each laboratory work and is given to the student together with the assignment. The number of penalty points is no more than 12.*

# Types of control and rating system for evaluating learning outcomes (RSO)

*Types of control and evaluation system:*

* *4 laboratory works. Each laboratory work has the following evaluation system:*
  + *impeccable work - 15 points;*
  + *there are certain shortcomings in the completed work - 14-11 points;*
  + *there are certain shortcomings in the completed work program - 10-6 points;*
  + *Penalty points (up to 3 points) are charged for untimely completion and defense of laboratory work.*
* *4 modular test papers (MKR) — 10 points. The control task of this paper consists of test questions. 1 point is awarded for each correct answer to a test question;*
* *semester control — credit. Credit points are calculated as the sum of points for laboratory and control work and is equal to a maximum of 100 points.*

*Calendar control (attestation): is carried out twice a semester as a monitoring of the current state of fulfillment of the syllabus requirements. The condition for the first attestation is to obtain at least 10 points (at the time of attestation). The condition for the second attestation is to obtain at least 30 points (at the time of the attestation).*

*The conditions for admission to the semester control (credit) are the enrollment of all laboratory works and a semester rating greater than or equal to60ballam*

*Table of correspondence of rating points to grades on the university scale:*

|  |  |
| --- | --- |
| *Scores* | *Rating* |
| *100-95* | *Perfectly* |
| *94-85* | *Very good* |
| *84-75* | *Fine* |
| *74-65* | *Satisfactorily* |
| *64-60* | *Enough* |
| *Less than 60* | *Unsatisfactorily* |
| *Admission conditions not met* | *Not allowed* |

# Additional information on the discipline (educational component)

*Within the framework of the discipline, one laboratory work is included as an online course on the Coursera portal or similar.*

***Working program of the academic discipline (syllabus):***

***Folded*** *associate professor of the PZKS department, Ph.D., Petrashenko A.V.*

***Approved*** *by the PZKS department (protocol No. 11 dated 06.24.22)*

***Agreed*** *by the methodical commission of the faculty (protocol No. 9 dated 06.24.22)*